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Exploration and Analysis of Glitch Sizes and their Patterns from 112 New Glitches in 30 New Pulsars

A pulsar is a type of highly-magnetized rotating neutron star, whose radiation emission is received by Earth in periodic pulses. While their rotation is typically extremely stable, some will occasionally experience a sudden increase in rotational frequency in an event known as a glitch. It is suspected that glitches occur when a build-up of angular momentum is transferred from the inner superfluid of the star to the outer crust, and they vary in size depending on the breaking point that triggers this transfer. Studying glitch size properties and their correlations with other parameters of the pulsar can tell us more about the causes and conditions of these breaking points, which are currently unknown. This study combines the major methodologies of previous studies of pulsar glitches to complete the first comprehensive exploration and analysis of glitch sizes and their patterns, using a combination of previous data along with almost 4 years worth of new data, which is analyzed for the first time in this work. A previous hypothesis made by Fuentes et al. (2019) suggesting there are two kinds of glitches - large ones with a correlation between glitch size ($\Delta\nu$) and the time until the next glitch ($\Delta\tau$k+1) and small, uncorrelated ones - is not followed by the situations of half of the pulsars in the sample with ~10 or more recorded glitches. This key result suggests that the hypothesis cannot be applied to a sizable portion of the glitching pulsar population, indicating that there are far more complex conditions, or even multiple varying conditions at play here, resulting in multiple explanations as to what causes a pulsar's glitch breaking point. These findings propose that there is more to be understood about potential differences in the internal structures of these stars, and exploring this would open up even more opportunities to study the physics of matter in realms of extreme density, such as those present within a neutron star.